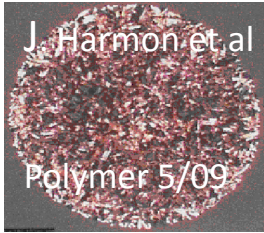


# MS & FLUIDICS RESEARCH OPPORTUNITIES & IP OFFERINGS.



**Crystallography**

## **nanoLiter LLC.**

217 Garfield Drive  
Henderson, NV, 89074, USA  
nanoliter.com,  
Drew Sauter, President  
adsauterjr@gmail.com  
702-882-5413



**Drug Analysis**

## **Cool IBF Science Video.**

**Dispensers  
nanoLiter Cool Wave I**



**Defense Tools  
Army's APG-X1**



**Robotic Systems**



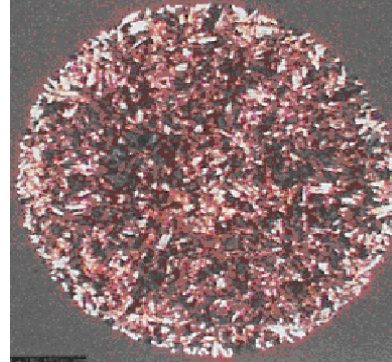
**Android Dispensing, MS Systems  
nanoLiter Programmable Wave.**



# APPLICATION SPACES FOR OUR TECHNOLOGY, INDUCTION BASED FLUIDICS (IBF).



MALDI, TLC, etc. Dispensing.



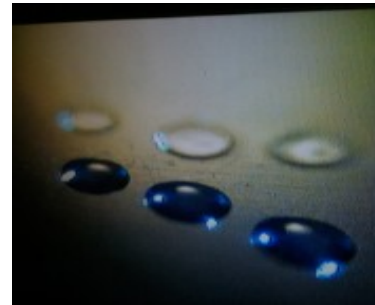
Crystallography



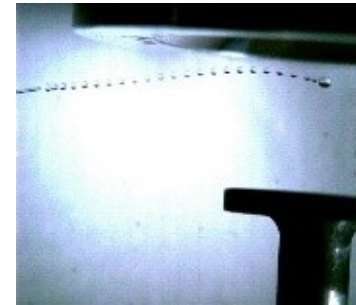
Marijuana, Drug Testing.



Defense



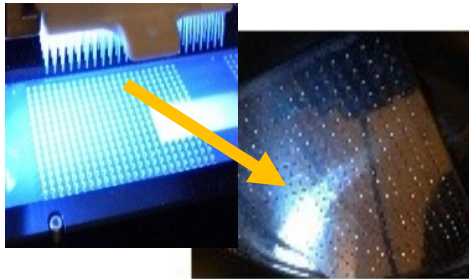
LO 3D Print



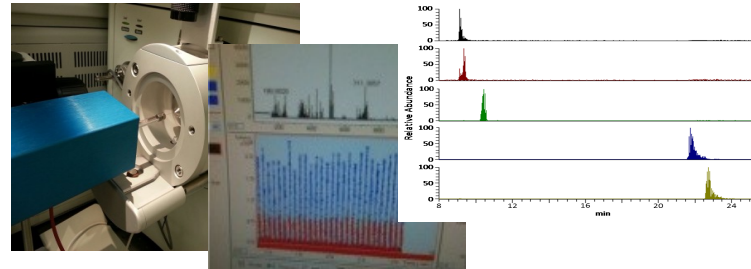
Pure Science



Android MS Dispensing



Highly Parallel Manufacturing



Rapid MS Sample Infusion or UPLC MS.



IP Development, Acquisition.



# IBF MORPHS SYRINGES, PIPETTES, CHIPS, PUMPS INTO non-TOUCH nL DISPENSERS THAT CAN ALSO BE ION SOURCES!

Morphs Common Devices Into NEW powerful non-touch nL dispensers for  
MALDI, ESI, TLC, PCR, microscopy, blood, glue & CBRN dispensing, SPE, crystallography, more!

IBF owns the future of these common devices found in labs everywhere + expendable tips!

## Syringe/s



**nanoLiter Cool Wave.**

## Pipette/s



**nL Pipette & Dispensers**

Patented **Expendables**, i.e., tips exist for these devices as well.

## LC/s, Pump/s



**nL dispensing set up and tools.**

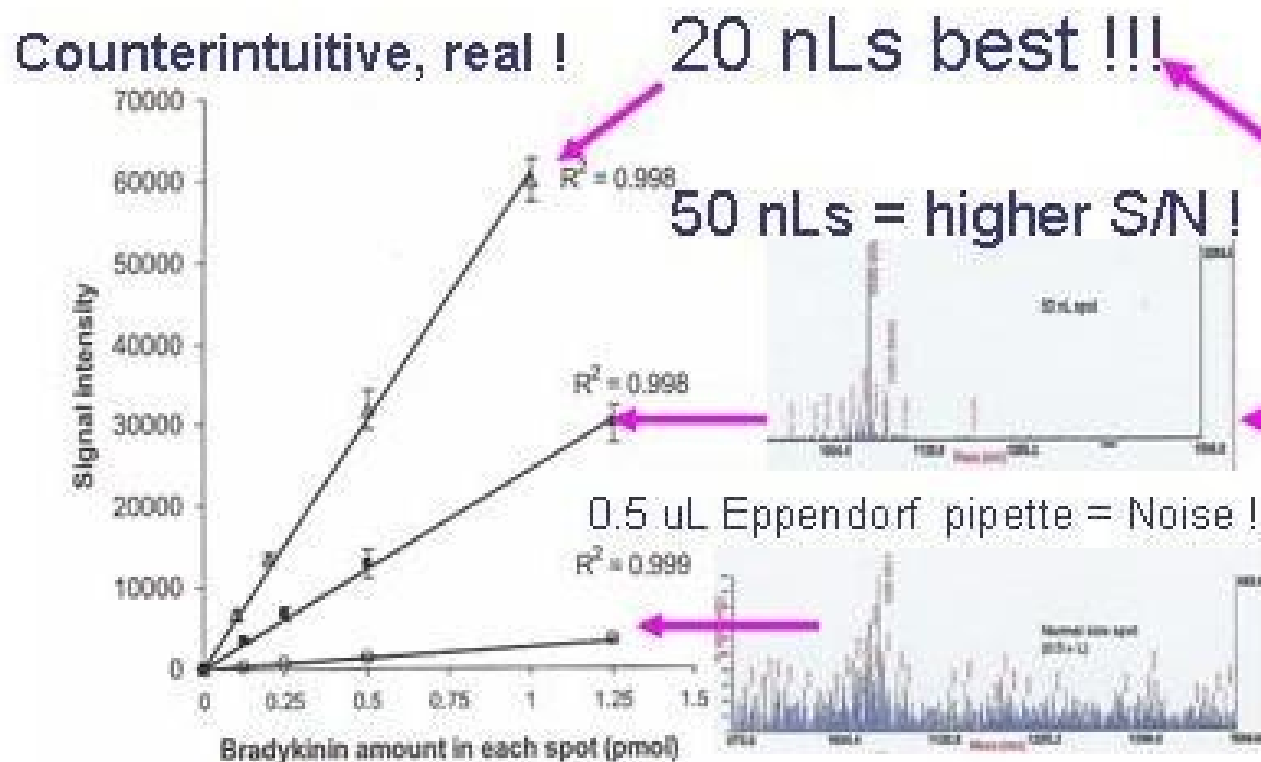
# IBF ALSO YIELDS MAJOR (>10x) SENSITIVITY INCREASE FOR MALDI, SIMS & LDI!

Below, 20 nLs yields 20 x the ion current than 0.5 uL MALDI sample! Astounding\*!

[Print samples!](#)

nLs spatially concentrated, nLs evaporate rapidly = smaller crystals. Much less noise (See +eV, reflectron mode MS below.)

NIST, USF, JEOL, Genentech have published very similar observations for SIMS (RDX, cocaine), MALDI polymers, LDI and DART ( 8 drugs of abuse)! nL quantities of sample produce major increases in sensitivity as compared to uL samples acquired identically. Dr. Enke observes:" Astounding."



T. Tu, M. L. Gross, et al, JASMS, 8/08.



Tu, T., Sauter Jr., A.D.; Sauter III, A.D and Gross, M.L., Improving Intensity and Sensitivity of MALDI Signals by Nanoliter Volume Spotting, poster session presented at ASMS2007, Indianapolis, IN, June 2007. Journal of the American Society of Mass Spectroscopy 2008, 19,

\* Co-inventor of QQQ MS

# IBF YIELDS 100% ESI INFUSION or 100% ESI UPLC MS/MS..... INPUT EFFICIENCY!

AN INTERNATIONALLY UNIQUE TOOL SET for MALDI & ESI IN ONE DEVICE!

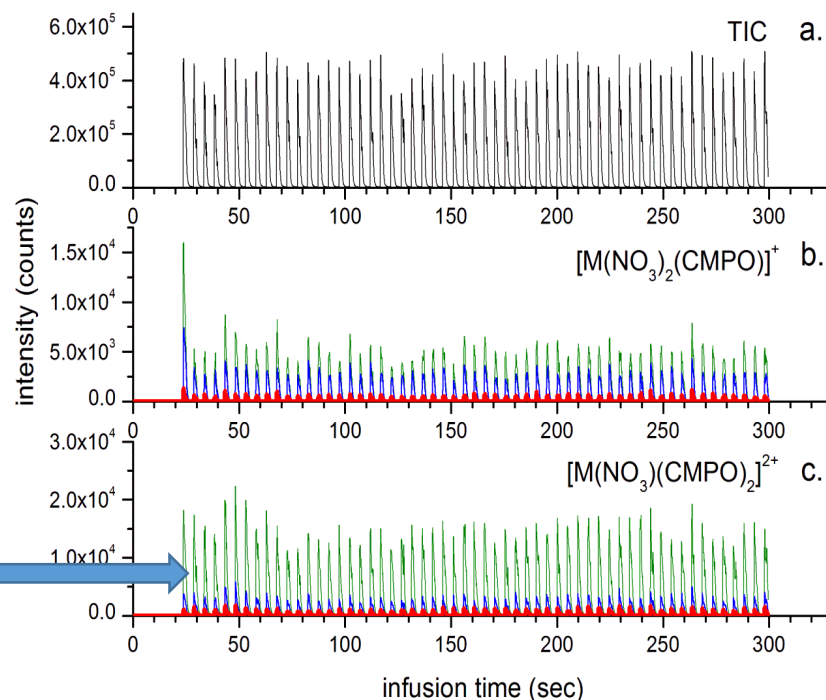
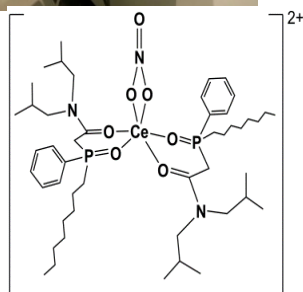
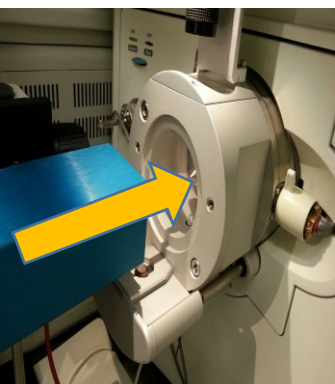
Fastest (msec), most versatile, efficient (100%, less) & simplest MS sample introduction technology in the world !

Fly cells, nanoparticles, samples into ESI MS's or onto surfaces [like this](#) or [this](#) or [this](#)!

## INFUSION

nL Programmable Wave for, rapid  
100% Input Efficient non-touch,  
nL dispensing for BOTH MALDI & ESI!

Shoot 100% of drops  
Into ANY ESI MS or  
onto MALDI plates!



Analy. Chem. June 2013, + ion profiles generated by individual droplets.

G. Groenewold, et al, Idaho National Lab.

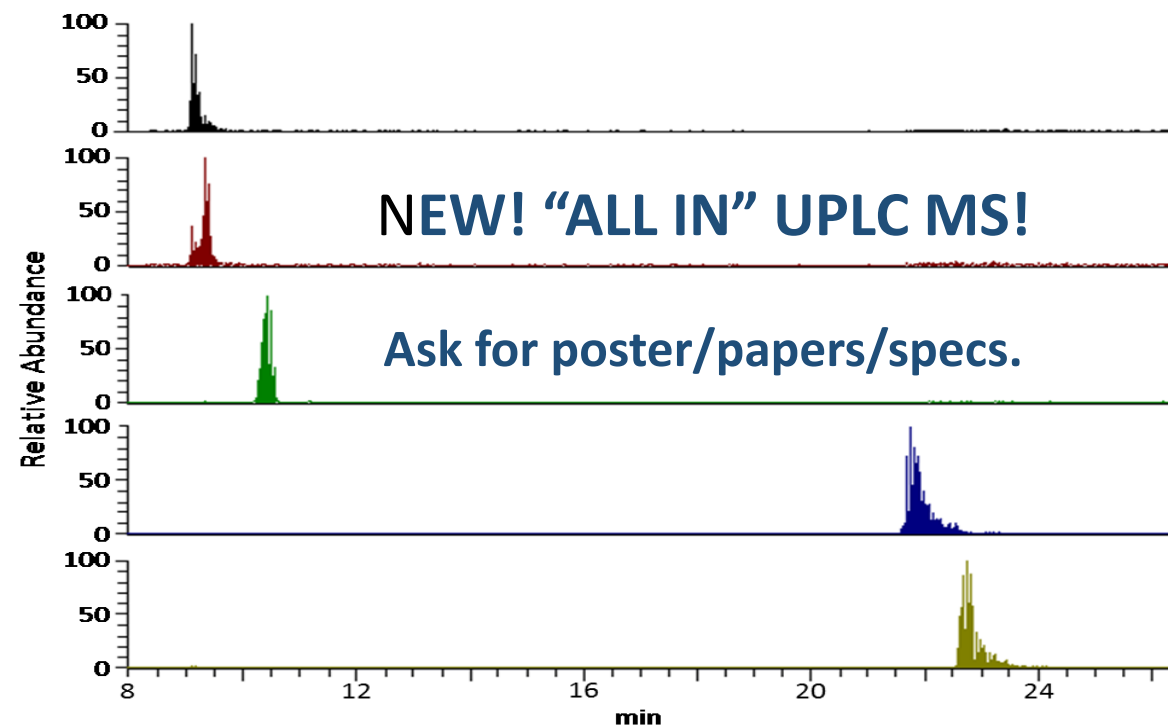
a.  $[M(NO_3)_2(CMPO)_2]^{2+}$ . Blue =  $Ce^{3+}$ , Green =  $Tb^{3+}$ , Red =  $Lu^{3+}$ .

c. Bruker u-ToF, +eV, reflectron, 12 Hz, 50-2000 amu. Above Pic = XP trap

. Total ion current. b.  $M(NO_3)_2(CMPO)^+$ .

## UPLC ESI MS ASMS 2017 & Asilomar '16.

nL Programmable Wave, 100% Input Efficient UPLC MS.  
Program drop energy, wave, polarity, locale & timing.



**NEW! "ALL IN" UPLC MS!**

Ask for poster/papers/specs.

Extracted ion chromatograms of nucleosides cytidine, uridine, 5-methyluridine, adenosine, and 2'-O-methyladenosine separated on a PGC capillary column and introduced into the mass spectrometer by inductive charging.. 40 min run. Asilomar 2016. Also see JMS Oct. 2015, Drs. Ross & Limbach, U of Cinn.



# IBF MORPHS ROBOTIC DISPENSERS INTO NON-TOUCH nL DISPENSERS OR ION SOURCES.

(APPS = UPLC MS, CRYSTALLOGRAPHY, SPE, TLC, MALDI, SIMS, LDI, GLUING, PURE SCIENCE & MORE)

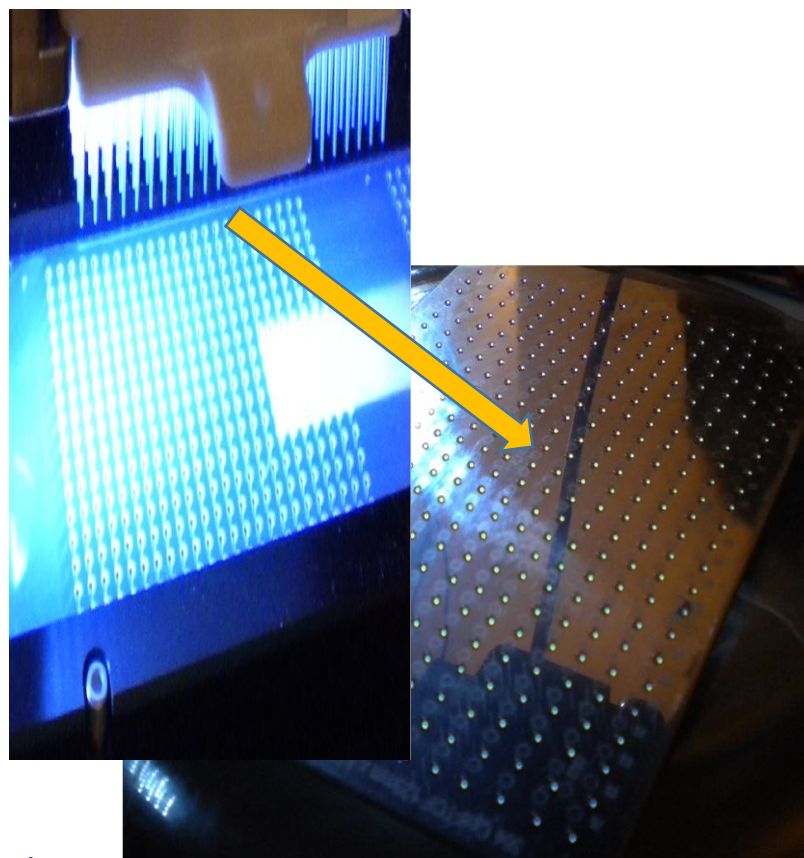
## 150 nLs from Roche Polypipette, non-touch.

Dispense time = One Millisecond!

384 Channel, IBF Parallel Dispense.

Uses one source of energy for 384 channels!

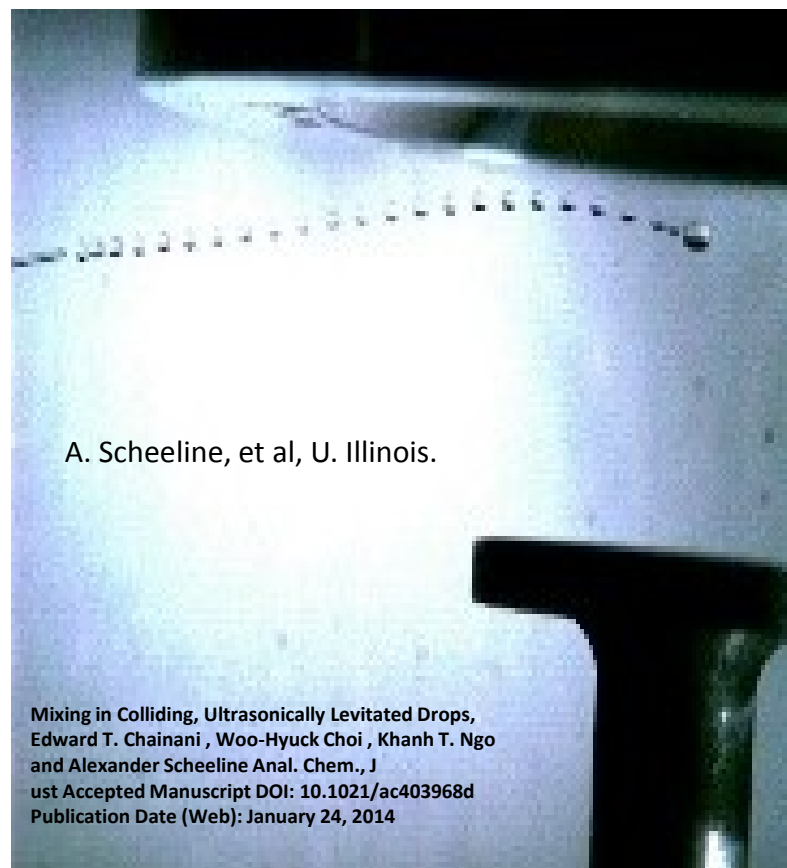
Directs liquids to target.



## Fly nanoLiters into levitated uLs!

Scheeline, et al, U. Illinois.

[See Cool Science IBF Video.](#)



## Spark Holland, Alias

Single Channel millisecond Dispense.

250 Milliseconds + movement.

ca. 30 nLs

Excellent crystals = High Sensitivity!



# IBF DROPLETS SHOT DIRECTLY FROM A Li+ BATTERY (W/FIRE RETARDANTS) INTO A MS!

By Dr. G. S. Groenewold, et al, Idaho National Lab. Device, early input from nanoLiter LLC.

- Coin cells: dependent on Li<sup>+</sup> transport in carbonate electrolyte – weakly coordinating solvents

- EMC
- EC

- Breakdown can lead to H<sub>2</sub> production, flammability issues

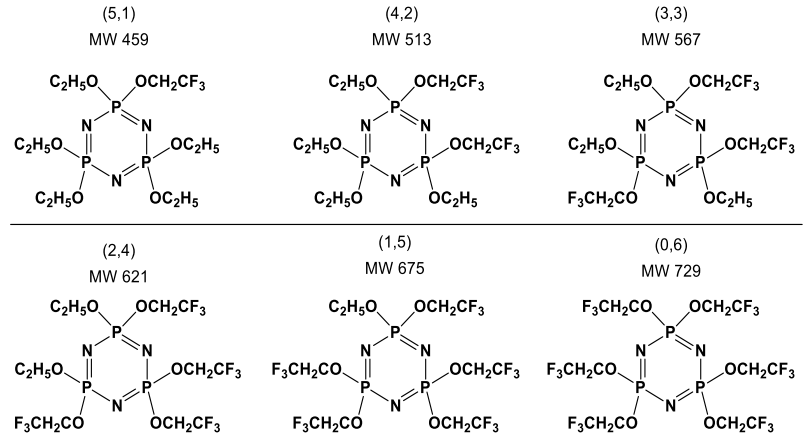


100% Shot Into An ESI MS !



## Lithium ion battery fire retardants

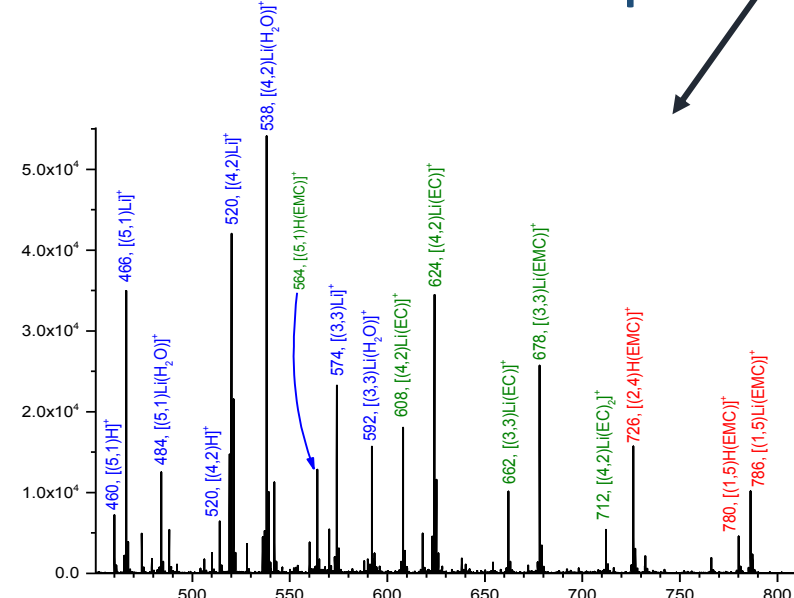
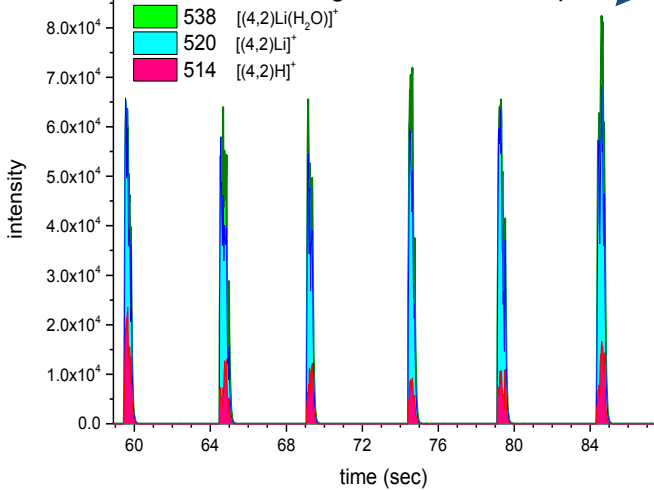
(Ethoxy)<sub>x</sub>(2,2,2-trifluoroethoxy)<sub>y</sub>phosphazene cyclotrimers  
(x,y) short hand nomenclature



## Electrolyte Droplets Shot Into ESI!

## HRMS of nanoLiter droplets!

Extracted ion chromatograms, 100 nL droplets

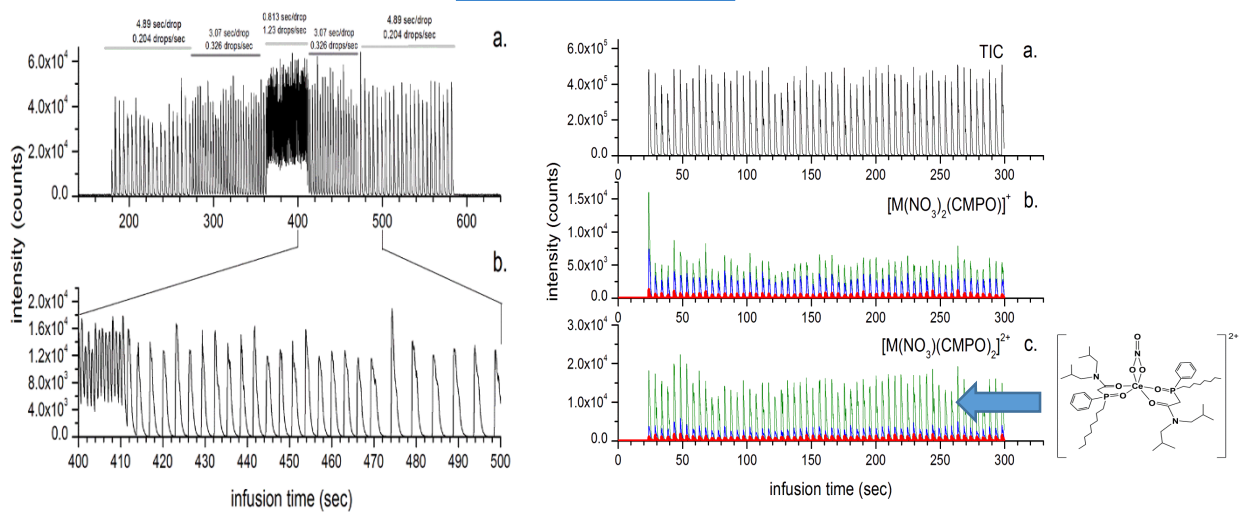


# AN INTERNATIONALLY UNIQUE TOOL SET for MALDI, ESI & MORE IN ONE IBF DEVICE!

Fastest (ms), Most Efficient (100% or less), Precise MS Sample Introduction System In The World, LITERALLY!

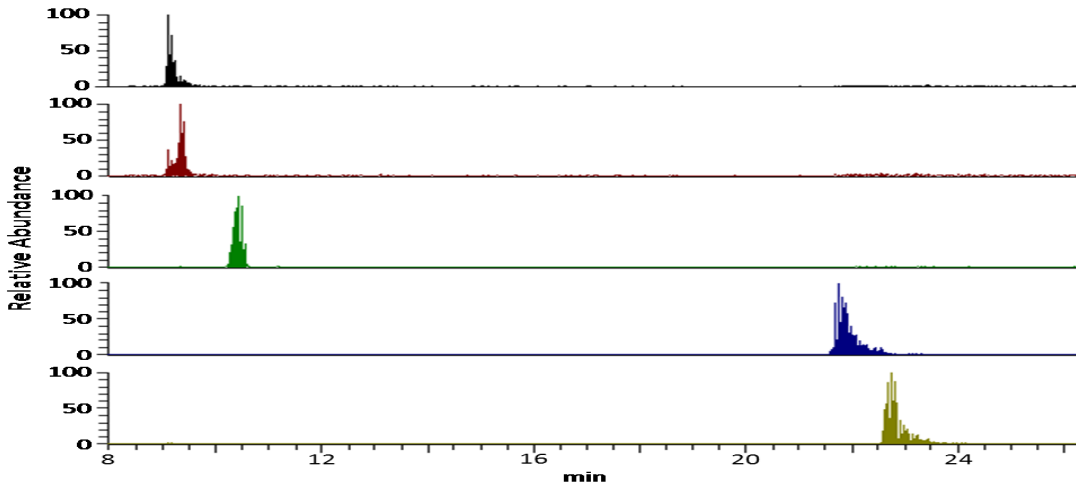
(W or w/out a funnel. Acquire standard ESI MS for Oligo's, Drugs, Proteins/peptides, metals (+ Lanthanides, Actinides!), inorganic to fgs using old ion traps ! to ags w/ HR ToFs?)

## ESI INFUSION.



Varied infusion rate. Positive ion profiles generated by individual drops. a. Total ion current. b. [M(NO<sub>3</sub>)<sub>2</sub>(CMPO)]<sup>+</sup>. c. [M(NO<sub>3</sub>)(CMPO)<sub>2</sub>]<sup>2+</sup>. Blue = Ce<sup>3+</sup>, Green = Tb<sup>3+</sup>, Red = Lu<sup>3+</sup>.

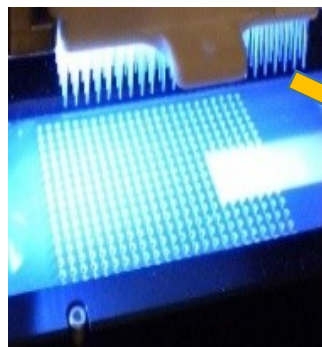
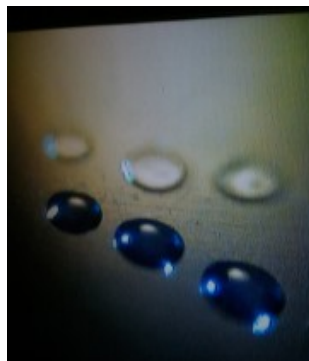
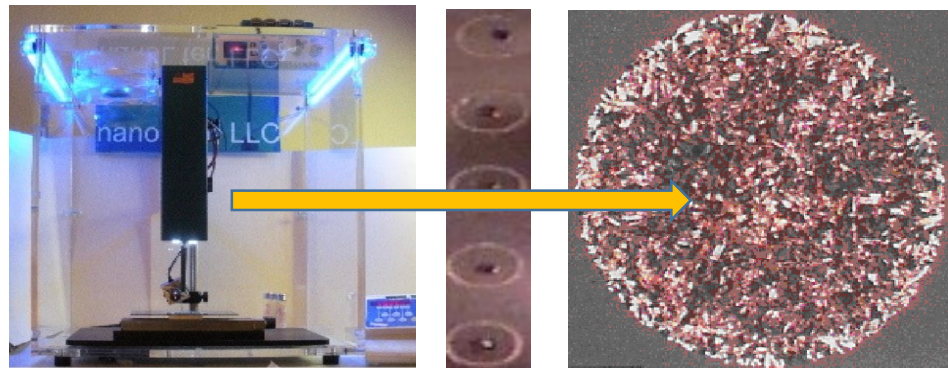
## ESI UPLC MS



Extracted ion chromatograms of nucleosides cytidine, uridine, 5-methyluridine, adenosine, and 2'-O-methyladenosine separated on a PGC capillary column and introduced into the mass spectrometer by inductive charging.. 40 min run. Asilomar 2016. Also see JMS Oct. 2015, Drs. Ross & Limbach, U Cinn..

The SAME DEVICE makes excellent MALDI, SIMS, LDI, other, crystals! Good for TLC! Spatially concentrate matter easily!

MALDI →





# IBF USER SUCCESSES.

100% input efficient UPLC MS reported at ASMS Asilomar meeting 2016 and at ASMS 2017 w/ U of Cincinnati! Ask for info.

IBF used by the **US Army** (Validated from 5 to 500 nLs) and **US Air Force** for classified dispensing projects and MS R&D w/ GoPro camera.

nanoLiter receives pipette/MS patent from USPTO to go with syringe and LCMS patents, filing additional pending patents..

IBF is being used for MS Analysis of Oligonucleotides. See Oct 1015 JMS paper w/ **U of Cincinnati** yielding the most sensitive MS analysis for oligonucleotides!

Agilent's John Sausen calls nanoLiter, requesting information on IBF which is 20x faster and places 100x more into the ESI than their technology.

**US Department of Energy** is using IBF in the field to analyze Lanthanide and Actinide elements at fg levels **WITHOUT** an ICP!

IBF is also being used to introduce samples into a MS from an **OPERATING** Lithium battery at INL. App for TESLA here in Nevada?

Stanford Prof. exclaims, "It works." in first demo of our Android MS sample input device, the nanoLiter Programmable, fall 2016.

**USF, NIH, NIST & JEOL** publish that by using nLs for MALDI, SIMS, LDI & DART that MS sensitivity increases by 10,20-100x **LITERALLY!**

**USF** used IBF to make electrets and published papers on MALDI of polymers and fundamentals of IBF.

**University of Wisconsin** has used IBF for single cell MALDI identifying six new ocular proteins. We shot cellular matter into an ESI at gov't lab.

**University of Illinois** published in AC that IBF can fly nanoLiters of liquids into levitated microliters to study wall-less reaction kinetics.

For **Abbott**, nanoLiter LLC used IBF to dispenses PVA, w/ave. MW of 300,000 in pseudo 3D "printing." app.

**At Genentech**, nanoLiter demonstrates 20 x improvement in MALDI sensitivity for proteins, peptides.

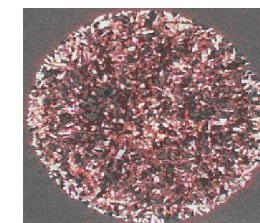
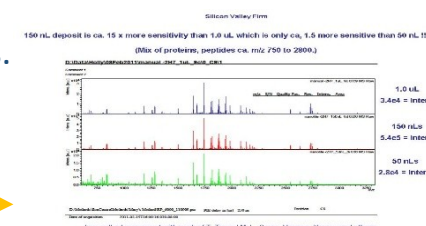
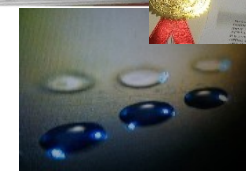
**NIH**, in it's first application of IBF, PTM's of tublin (glycosylation) were first id'ed, in actual brain cancer samples given a 100x MALDI sensitivity increase claims NIH!

**Sciex** offered to license IBF for ESI LCMS and for LC/MALDI. Parallel 8 channel IBF LC demoed with dyes.

**nanoLiter** morphs Roche polypipettor for **Douglas** and **Spark Holland's** systems for parallel or single channel millisecond nL dispensing, SPE, LC.

See more here. <http://www.nanoliter.com/nanoliterhasdone121213ver3.pdf> & some references, <http://nanoliter.com/references2014.pdf>

Example customers, clients: U's of Ill, WI, CA, Cinn., MUSC, Wash. U., USF, USU, US Army APG, ECBC and Natick, Abbott, Biogen Idec, Genentech, Amgen, Hitachi, Allergan, Spark, Douglas, NIH, NIST, USDOE INL, Ga Tech, UNH, Duquesne, NASA, Air Force, Air Force, and Sciex offered to license. +. Agilent's John Sausen request IBF information.

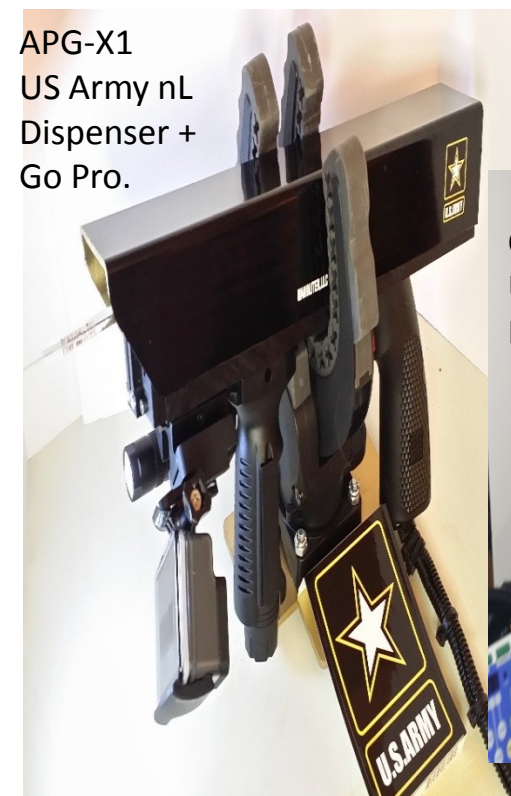


# Nanoliter

## nanoLiter LLC

Examine our excellent user [successes](#) & [references](#) with our poly-patented & pending IBF technology. See [100% All In](#), UPLC LCMS DATA, a world's first!

**Selling devices, licenses & IP. Seeking customers, collaborators & partners.**



Drew Sauter, President, 217 Garfield Drive, Henderson, NV, 89074, USA, 702-882-5413, [adsauterjr@gmail.com](mailto:adsauterjr@gmail.com), [nanoliter.com](http://nanoliter.com)